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Status of *Erythrina sandwicensis* in the NifTAL Experiment Site, Kaho'olawe, Hawai'i: A Reassessment

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Abstract. In 1989 University of Hawaii NifTAL researchers established a field trial to identify fertility-related constraints to the re-establishment of the native tree species *Erythrina sandwincensis* (*wiliwili*) on highly eroded soils of Kaho'olawe Island, Hawaii. In 1996 we re-surveyed this trial to examine the long-term effects of the fertility treatments on the growth of *wiliwili*. After seven years, survival of the trees in the field trial was 95%. Trees receiving applications of phosphorus (P) and zinc (Zn) at planting were significantly larger and more vigorous than those that did not receive P and Zn. Successful re-establishment of the nitrogen-fixing *wiliwili* on eroded Kaho'olawe soils will likely depend on P and Zn inputs.

Kaho'olawe Island, Hawai'i once supported diverse native dryland forests. Most of the native ecosystems have been lost through a series of changes in land use. Today about one-third of the island is

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a largely barren plateau, commonly referred to as the "hardpan". Original dry forest vegetation may have initially given way to a grassland in some areas as a result of agricultural practices, particularly burning, by Hawaiians. Severe loss of vegetation and soil began with the introduction of goats in 1793, and the onset of western style ranching in the 1850s. Ranching was discontinued after the U.S. Navy took control of the island for training purposes in 1941; however, feral goats remained, denuding much of the island's summit. The goats continued to thwart restoration efforts until they were finally eradicated in the early 1990s.

Today vegetation on the hardpan consists mainly of introduced species including *kiawe* (*Prosopis pallida*), tamarisk (*Tamarix aphylla*), buffelgrass (*Cenchrus ciliaris),* Natal redtop (*Rhynchelytrum repens*), lantana (*Lantana camara*), *koa haole* (*Leucaena leucocephala*), and pitted beardgrass (*Bothriochloa pertusa*). Native *pili* grass (*Heteropogon contortus*), *'ilima* (*Sida fallax*), and indigenous (status uncertain) *'uhaloa* (*Waltheria indica*) are also present. The first revegetation efforts introduced exotic species such as *kiawe* and Australian saltbush (*Atriplex semibaccata*). More recent efforts have been concerned with reestablishing native species like *wiliwili* (*Erythrina sandwicensis*), a dominant dryland forest species. Restoration of native species on Kaho'olawe is difficult because of (i) severe soil erosion that has reduced available nutrients, organic matter, and microbial activity; and (ii) harsh climate, which includes low seasonal rainfall, high solar radiation, high potential evaporation, and strong, persistent trade winds. A history of environmental degradation and prior revegetation projects are provided in other works (Kaho'olawe Island Conveyance Commission, 1993; Giambelluca et al., 1997).

In November 1989, University of Hawaii NifTAL (Nitrogen Fixation by Tropical Agricultural Legumes) researchers, with the support of the US Navy, installed a split-plot field trial on the hardpan to identify microbial and mineral constraints to re-establishing the *wiliwili* tree, an endemic nitrogen-fixing leguminous species (Nakao et al., 1993). Analysis in 1990 by NifTAL researchers confirmed the experimental hypothesis that phosphorus + zinc inputs, combined with the reintroduction of the *wiliwili* microbial symbiont for nitrogen fixation, would enhance the success of reestablishing *wiliwili* on the hardpan (Nakao et al., 1993). In 1996 we re-surveyed the NifTAL experiment site to determine the survival of the experimental trees and the long-term effects of the various treatments.

Study Area

The NifTAL experiment site is located on the hardpan between tamarisk (*Tamarix aphylla*) windbreak rows on gently sloping land near the northern rim of Lua Makika, the shallow caldera at the summit of Kaho'olawe. The soil of this area is largely the Bw horizon of an exhumed paleosol, dominated by the *Kaneloa* soil series—which resembles the Molokai Oxisol of Hawai'i (Soil Conservation Service, 1976; Nakamura & Smith, 1995). Soil hydrological, chemical, and physical properties associated with the *Kaneloa* Oxisol are listed in **Table 1**. In general tropical Oxisols are deficient in nitrogen, phosphorus, potassium, sulfur, zinc, and molybdenum (Manrique, 1993). Warren et al.,(1988) determined the low levels of phosphorus and zinc to be limiting nutrients for revegetation in Kaho'olawe soils. Additionally they found levels of potassium to be very high; sodium, iron, copper, sulfur, and boron to be high; and calcium and magnesium to be adequate. Estimated mean annual rainfall on Kaho'olawe is 371 mm, with nearly 70% coming between November and March (Ziegler & Giambelluca, 1997).

The Original NifTAL Experiment on Kaho'olawe

In November 1989, a split-plot experimental design was implemented at the NifTAL site (Nakao et al., 1993). The main plots were designed to measure long-term effects of P and Zn fertilization; the subplots tested short-term N-source effects within the two main plots (Fig. 1). There were four replications of six treatment combinations (Table 2). Each subplot consisted of 20 seedlings, planted in five rows of four trees, with a spacing of 1.5 m, for a total of 480 seedlings. Details of seedling germination and inoculation are described by (Nakao et al.,1993). At six months, the seedlings were planted with fertilizer treatments in 15 cm diameter holes created in the hardpan with explosives. The trees were watered immediately following planting, but long-term irrigation was not used.

Basal diameter (*BD*), height (*h*), and stem volume (*SV*) of the inner six plants in each

Table 1. Chemical, Physical & Hydrological Characteristics of the Kaneloa Soil Series on Kaho'olawe Island.

Soil Characteristics	Units	Value†
From Warren et al.,(1988)		
Phosphorus (Bray P1)*	kg ha^{-1}	2.0 ± 0.0
Phosphorus (Bray P2)	kg ha^{-1}	3.8 ± 0.6
Potassium	kg ha^{-1}	629.2 ± 166.4
Calcium	kg ha^{-1}	2004.3 ± 487.9
Magnesium	kg ha^{-1}	739.4 ± 164.4
Sodium	kg ha^{-1}	1869.2 ± 878.2
Zinc	mg kg^{-1}	950 ± 450
Synthesized from data of Nakamura and Smith (1995)		
Nitrogen	—	*low*
Exchangeable Ca^{2+}	cmol (+) kg^{-1}	3.61
Exchangeable Mg^{2+}	cmol (+) kg^{-1}	2.88
Exchangeable K^{+}	cmol (+) kg^{-1}	1.27
Kaolinite / Halloysite	—	moderate
Gibbsite	—	moderate to large
Soil texture	—	Silty clay loam
Available water capacity	m/m	0.10 - 0.14
Drainage class	—	well-drained
Depth to bedrock‡	m	> 1.5
Determined in this study§		
pH in water (1:1)	—	6.4 ± 0.3
Organic carbon	g kg^{-1}	0.85 ± 0.15
Sat. hydraulic conductivity	mm h^{-1}	72.3 ± 33.1
Field bulk density	g cm^{-3}	1.10 ± 0.06
Soil moisture at saturation	—	0.46 ± 0.04
Soil strength	bars	4.51 ± 2.65
silt/clay fraction	—	0.09 ± 0.01
Typical surface material	—	duracrust/durapan

*Phosphorus was extracted with Bray P1 (1:10 soil: solution of 0.03 ammonium fluoride and 0.025N HCl) and P2 (1:10 soil: solution of 0.03 ammonium fluoride and 0.1 HCl).

† Values are ± one standard deviation about the mean.

‡ Parent material is strongly weathered volcanic ash over strongly weathered basic igneous rock.

§ Data are for 5 soil samples taken near the NifTAL site except for Zn data, which was collected at 4 locations within the CERL experimental watershed (Warren and Aschmann, 1993).

subplot were determined by NifTAL researchers four months after planting (Nakao et al.,1993). Inoculated seedlings at both high and low P/Zn fertility levels had the greatest relative increase in *SV*; however, direct comparisons of *SV* among the various subplots showed few significant differences. At that time, block effects were significant, with plants at the bottom of the slope with the largest *SV*. This effect indicated water availability was likely affecting the experimental results.

Methods

For the reassessment reported herein, height and basal diameter of the inner six trees within each sub-plot were measured in 1996. Stem volumes were not calculated, as was done in the 1990 assessment, because the trees no longer had conical stems. Two-factor ANOVA was used to assess interaction between the two application rates of P + Zn and the three N-source treatments. If during ANOVA testing, significant differences were detected within factors, post-hoc multiple comparison testing using Fisher's Protected Least Significant Difference test (FPLSD) was used to identify statistically indistinguishable groups. Because the untransformed data were positively skewed (all skewness values > 1.0 for $n \geq 24$), *h* and

Table 2. Characteristics of the NifTAL split block design. The main block was designed to test two application rates of phosphorous and zinc fertilizer; the sub-block, three nitrogen-source treatments, including rhyzobial inoculation. TI=Treatment Identifier.

TI	(kg ha^{-1})	(kg ha^{-1})	(kg ha^{-1})	(yes/no)
LI‡	0	0	0	y
LN	0	0	200	n
L	0	0	0	n
HI	800	5	0	y
HN	800	5	200	n
H	800	5	0	n

† Fertilization rates for phosphorus (P), zinc (Zn), and nitrogen (N).

‡ L = no P/Zn applied; H = high P/Zn application rate; I = inoculated; N = nitrogen applied.

BD values were log-transformed to stabilize variances and approach normality as suggested by Zar (1996).

Results

Of the 480 trees planted in 1989, 458 had survived in 1996 (95%). The survival rate was higher until early 1996 when removal of military ordinance in the area caused several trees to be lost (Dan Holmes, Protect Kaho'olawe 'Ohanna, pers. comm., 1997). Many of the trees showed insect damage and did not appear healthy. The field site was barren hardpan when the experiment was planted, and now supports various, mostly alien, grass species between the trees—total cover is < 10% in most areas.

Two-factor ANOVA testing of the P + Zn application rates and the inoculation treatments indicated (i) significant differences in *h* and *BD* between the high and low application rates of P/Zn; (ii) no significant differences in *h* and *BD* among the N-source treatments; and (iii) no interaction between the P/Zn treatments and the N-source treatments. All treatments that received P + Zn had greater biomass than the treatments that did not receive P and Zn (one-factor AVOVA). Mean values of *h* and *BD* are shown in Table 3.

Discussion

As there were originally no indigenous rhizobia detected in the hardpan soil prior to the planting, the original NifTAL investigators determined that the introduction of the microsymbionts through inoculation was

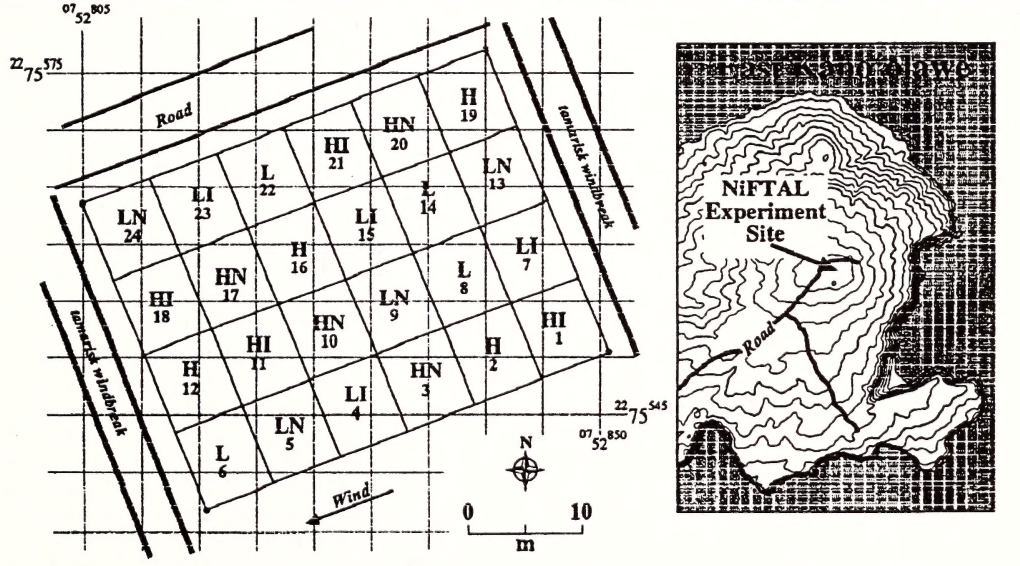

Fig. 1. The NiFTAL study area on eastern Kaho'olawe Island, Hawai'i. The six different treatments tested in each of the 24 planting blocks are described in Table 2. The site is sheltered on the windward side by a tamarisk (*Tamarix aphylla*) windbreak row.

Table 3. Mean values for height and basal diameter for *wiliwili* receiving one of two application rates of P and Zn, and various N-source treatments. Determined in 1996, seven growing seasons after planting. Treatments are described in Table 2. All data were log-transformed prior to statistical testing.

Treatment	LN	L	LI	HN	H	HI
Sample number*	24	22	24	23	21	24
Height (cm)†	38.8 ± 10.3[a]	39.5 ± 16.4[a]	34.4 ± 12.8[a]	74.5 ± 32.5[b]	64.2 ± 27.2[b]	78.1± 36.9[b]
Basal diameter (mm)	25.1 ± 12.7[a]	23.8 ± 7.4[a]	21.9 ± 8.2[a]	42.1 ± 15.4[b]	37.1 ± 15.8[b]	44.9 ± 19.4[b]

* Sample size refers to the number of living *wiliwili* out of a possible of 24 (6 inner planting locations x 4 plots).

[a,b]Mean values in a given row with the same letter are NOT significantly different (ANOVA, a= 0.01).

† Means are ± one standard deviation

necessary to establish a nitrogen fixing symbiosis for *wiliwili* at the site. Further, their initial analyses of the experiment in 1990 indicated that native soil nitrogen (treatment with neither rhizobia nor mineral N added) was insufficient to support maximal growth of the *wiliwili. Wiliwili* is a deciduous species with a high requirement for N; therefore, seven seasons of growth (1989 to 1996) would have exacerbated limitations due to inadequate soil N. Since differences can no longer be detected among the three N-source treatments (i.e., Table 2), we speculate the introduced rhizobia have spread throughout the experimental site through movement of water during rainstorms, and all of the trees are benefiting from symbiotically fixed N. In support, pre-planting inoculation trials by NifTAL researchers indicated loss of "uninoculated" control treatments to cross contamination is generally inevitable after four months, even in carefully managed environments (Nakao et al., unpublished data).

Because P and Zn applications were combined in the NifTAL field experiment, it is not possible to determine the individual contributions of each nutrient in producing the increased biomass. Soil tests indicate that both nutrients occur in low concentrations on the island (Warren et al.,1988). The application rate of P was high at 800 kg ha^{-1} (per hole basis)—a rate that may not be practical in large scale revegetation efforts. In a pot test, *wiliwili* grown in the hardpan soil, amended with seven levels of P, required 800 kg P ha^{-1} to maximize growth potential after four months; however, when *wiliwili* was inoculated with vesicular arbuscular mycorrhiza (VAM), the level of P required to maximize growth potential was reduced to 200 kg ha^{-1} (Nakao et al.,1993). Further research in the field is needed to determine optimal rates for P inputs, and to increase the efficiency of the inputs through VAM.

In 1990, NifTAL investigators found that seedlings planted at the same time as the experimental trees but at another site (CERL Phase II, see Giambelluca et al.,1997 for review) were developing more biomass than the NifTAL experimental trees. The trees at the CERL II site were inoculated and fertilized similarly to those in the HI treatment, but were planted in loose soil along 1-m high soil berms. Vegetative ground cover is higher at the CERL II site (73% compared to the nearly barren experimental site). Our survey of 40 trees at the CERL II site again indicated these trees were considerably larger than those at the experimental site. The CERL II trees had *h* and *BD* of 162.3 cm and 68.0 mm, respectively. Several factors may contribute to the increased growth of *wiliwili* at the CERL II site: (1) the trees may benefit from increased soil moisture resulting from higher water infiltration and capture from the berms in which they were planted, e.g., mean saturated hydraulic conductivity at the NifTAL site is approximately 73 mm h^{-1}, compared to 180 mm h^{-1} in the CERL II site (estimated from data in Ziegler & Giambelluca, 1997); (2) increased vegetation at CERL II may have accelerated VAM infection of the *wiliwili* root systems; and (3) the berms may have provided greater wind protection to the seedlings than is available at the experimental site.

The survival rate of the *wiliwili* trees at the NifTAL and CERL II sites is high compared to other sites on the island. At the CERL Phase I site (Warren & Aschmann, 1993; Ziegler et al.,unpublished), only 14 of 103 *wiliwili* trees planted in 1991 have survived. At two other sites

(U.S. Forest planting exclosures 4 and 5), only six of 88 *wiliwili* planted in 1971 and 1973 now survive. These low survival rates at the CERL Phase I and U.S. Forest Service sites can be attributed at least in part to the much greater wind exposure at these locations compared with the CERL II and NifTAL plantings (Giambelluca et al., 1997).

Conclusions

1. There are significant long-term benefits to P and Zn inputs in the re-establishment of *wiliwili* on the Kaho'olawe hardpan area.
2. Assuming nitrogen fixation is occurring within the site, *wiliwili* can probably meet N requirements without mineral N inputs. Additional work is needed to verify nitrogen fixation within the site.
3. The comparatively better growth at the CERL II site indicates that the growth of *wiliwili* at the NifTAL site may be constrained by other factors, such as poor infiltration of water into the soil.
4. In regard to island restoration, 95% of the seedlings planted in 1990 survived on the hardpan without irrigation, demonstrating the resilience of this species, and thus, suitability as a revegetation species. However, low survival rates at other experiment sites on Kaho'olawe suggest that protection of *wiliwili* from the high winds is a necessary strategy for establishing the trees.

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We acknowledge Harold H. Keyser and Paul W. Singleton of the original NifTAL research team. We thank the following for their support in this re-assessment: John R. Egan, S. Kanani Garcia, and Fred Richardson (field data collection; historical research); Ross A. Sutherland; Renée Louis (cartography); and the U.S. Department of Navy, Army, and Air Force Explosive Ordnance Personnel. We especially thank Keoni Fairbanks and Paul Higashino (Kaho'olawe Island Reserve Commission) for their support in all phases of the re-assessment. Field research was partially funded by the Kaho'olawe Island Reserve Commission.

References

Giambelluca, T.W., Egan, J.R., Garcia, K., Louis, R., Perry, J.L., Richardson, F., Chun-Smith, A.A., Ziegler., A.D. (1997) Lessons Learned: Kaho'olawe Restoration Efforts Prior To 1996. Final Report. Kaho'olawe Island Reserve Commission, Honolulu, HI.

Kaho'olawe Island Conveyance Commission. (1993) Kaho'olawe Island: Restoring a cultural treasure. Final report to the Congress of the United States. xiv + 158 pp.

Manrique, L.A. 1993. Tropical Soils. In L.A. Manrique, Soil Management and Conservation in the Tropics. Manrique International Agrotech, Box 61145, Honolulu, HI, 96839. 215 pp.

Nakamura, S. & Smith, C.W. (1995) Soil Survey of Island of Kahoolawe, Hawaii. U.S. Department of Agriculture, Natural Resources Conservation Service, in cooperation with the United States Department of Navy, Pacific Division, Naval Facilities Engineering Command. Washington, D.C.

Nakao, P.L., Keyser, H.H., Bohlool, B.B., & Singleton, P.W. (1993) Soil constraints to the reestablishment of *Erythrina sandwicensis* in an eroded soil in Hawai'i. *Erythrina* in the New and Old Worlds (eds., S. Westely & M. Powell), pp. 322-329. NFTA-CATIE, Turrialba, Costa Rica.

Soil Conservation Service. (1976) Soil Survey, Laboratory Data, and Descriptions for Some Soils of Hawaii. Soil Survey Investigations. Report No. 29. U.S. Gov. Printing Office, Wash. D.C., 208 pp.

Warren S.D., Vachta, E.G., and Banwart, W.L. (1988) Rehabilitation proposal for Kahoolawe Island, Hawaii. U.S. Army Corp of Engineers Construction Engineering Research Laboratory, Champaign, Illinois.

Warren, S.D., & Aschmann, S.G. (1993) Revegetation strategies for Kaho'olawe Island, Hawaii. J. Range Manage. 46, 462 - 466.

Whitesell, C.D. & Wong Jr., H.C. (1974) Sixth progress report on vegetation trials for rehabilitating Kahoolawe Island, Hawaii. Pacific Southwest Forest and Range Experiment Station, Honolulu, HI.

Zar, J.H. (1996) Biostatistical analysis. 3rd ed. Prentice-Hall, Inc., Upper Saddle River, NJ. 662 pp.

Ziegler, A.D. & Giambelluca, T.W. (1997) The influence of revegetation efforts on hydrologic response and erosion, Kaho'olawe Island, Hawai'i. J. Land Degrad. Develop. (in press).

Ziegler, A.D., Perry, J.L., Giambelluca, T.W. & Warren, S.D. (unpublished) Reassessment of revegetation strategies for Kaho'olawe Island, Hawai'i. J. Range Manage. (in review).

Toward a Protocol for in vitro Propagation of *Scaevola coriacea* (Goodeniaceae)

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ABSTRACT. Three methods of micropropagating *Scaevola coriacea* (Goodeniaceae) were tested among 34 groups of plantlets. Explants not exposed to BA (Treatment 1) grew slowly and could not be subcultured frequently. Explants exposed to BA proliferated either shoots (Treatment 2) or callus then shoots (Treatment 3). The larger number of shoots was obtained from Treatment 2 explants. These had been placed in basal medium before being planted in BA medium. Plantlets from Treatments 2 and 3 exhibited morphological effects of BA exposure. One year later, these anomalies had all but disappeared. The results suggest that Treatment 2 might be used to consistently produce many *S. coriacea* plants. Further study is needed to ascertain how micropropagated *S. coriacea* will fare over time outside the laboratory.

Scaevola coriacea (dwarf naupaka, trailing naupaka, false jade plant) is a prostrate, perennial herb endemic to Hawaii. It was once seen in coastal areas on all the main Hawaiian islands except Kaho'olawe (Wagner et al. 1990). Today the only significant wild population known is on stabilized coastal dunes at Waiehu, Maui.

Scaevola coriacea is on the federal and Hawaii endangered species lists. Hence a recovery plan is required. The plant's thick, rounded, dark green leaves and low growing habit make it a ground cover of horticultural interest. But *S. coriacea* seems to be slow-growing and difficult to propagate conventionally (Goldstein pers. comm.; Sand pers. comm.). It may never have been very common in the wild (Wagner et al., 1990). Work is needed to determine how significant numbers of *S. coriacea* can be successfully grown.

The objective of this study was to identify an efficient means of micropropagating a quantity of *S. coriacea* for use in studies within botanical gardens. These investigations could determine 1) whether the plant might be successfully reintroduced to former wild habitats; and 2) its horticultural potential.

The project has had three parts. Part 1 (September-December 1995) established *S. coriacea* in culture in the laboratory. Part 2 (January-May 1996) tested three methods of shoot multiplication. Part 3 (May 1996-May 1997) involved subculturing to multiply the plantlets and to observe the persistence of the morphological effects of BA. Removal of the plantlets from test tubes to pots began in March 1997. The first group of "finished" plants was returned to Honolulu Botanical Gardens on Oct. 21, 1997.

This work was done under the direction of Dr. Yoneo Sagawa, Department of Horticulture, College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa, under state permits held by the University of Hawaii and Honolulu Botanical Gardens for work with endangered species. The following sections summarize two detailed, unpublished reports.

Materials and Methods

Cuttings were taken eight times in fall 1995 from either of two plants at Lili'uokalani Botanical Garden, Honolulu. Of 327 explants (apical and axillary buds) placed in culture, 136 were established. A disinfestation procedure was devised to overcome an initially high contamination rate.

For Part 2, the original eight groups of plantlets became 34 groups, differing by plant of origin, date of collection and hormone treatment. There were three hormone treatments: 1) Half-strength modified (vitamins added) Murashige and Scoog medium (basal medium), no hormones; 2) Basal medium first, followed by transfer to medium with BA added and, later, transfer back to basal medium; and

3) Medium with BA first, followed by transfer to basal medium.

The concentration of the cytokinin 6-benzyladenine (BA) used to stimulate cell division and shoot proliferation (Torres 1989) in Treatments 2 and 3 was 1.0 mg/L.

Results

Data for Part 2 were taken in April 1996, when all plantlets had been cultured 4.5-6 months.

Treatment 1: Plantlets decreased from 31 to 20.
Treatment 2: Plantlets increased from 39 to 184.
Treatment 3: Plantlets increased from 65 to 240.

The best-performing groups in Treatment 2 had spent five to seven weeks in BA medium, after spending at least nine weeks in basal medium. Many plantlets from Treatments 2 and 3 exhibited effects of BA exposure, including thickened stems, fasciation, small, cupped leaves and the persistence of basal shoot proliferation. One year later (end of Part 3), the number of plantlets produced from the original 136 explants was more than 1,500. The early morphological effects of BA exposure had almost completely disappeared.

Discussion and Conclusions

It might be preferable to produce *S. coriacea* without hormones, perhaps especially for use in outplanting projects. But this study indicates that *S. coriacea* is slow-growing in culture, as in nature. Micropropagation without hormones risks a net loss of plantlets due to attrition (failure to thrive, latent contamination). Given the scarcity of plant material, the resources involved in establishing and maintaining plantlets in culture, and the need to produce enough plantlets to overcome the challenges of acclimation, micropropagation without hormones does not seem worthwhile.

The next-best option may be to give explants a good start (9 weeks) in 1/2 MS basal medium before exposure to BA. This method (Treatment 2) could eliminate the risk of somaclonal variation posed by callus production (Cassels 1985, Karp et al. 1985). This procedure does not completely eliminate the risk of genetic variation, however, because adventitious buds and shoots may occur without being noticed (De Klerk 1990). For horticultural purposes, the possibility of variation that could not be detected except by molecular studies may not be significant.

This study shows that the callus route and risks, at least, can be avoided in the successful micropropagation of large numbers of *S. coriacea*. Further study is desirable to determine the minimum levels and times of BA exposure to which *S. coriacea* will satisfactorily respond. Acclimation studies also are needed before the full value of micropropagation as a means of increasing plant material for use in conventional horticultural studies and outplanting projects can be assessed.

Acknowledgements

This work was done as directed study toward a bachelor of science degree in horticulture. I thank Dr. Yoneo Sagawa for sharing his wisdom, for his help and encouragement, and for generously allowing the use of his laboratory. Thanks also are due Joshlyn Sand, horticulturist, Honolulu Botanical Gardens, for permission to take cuttings, and Dr. Gregory Koob, Lyon Arboretum Micropropagation Facility, who answered many questions along the way, drawing on his experience in the micropropagation of native Hawaiian plants.

Literature Cited

Cassells, A. C. 1985. Genetic, epigenetic and non-genetic variation in tissue culture derived plants. *In* A. Schafer-Menuhr (ed.). Advances in Agricultural Biotechnology, in vitro Techniques: Propagation and Long-term Storage. Martinus Nijhoff, Dordrecht, p. 111-120.

De Klerk, G. J. 1990. How to measure somaclonal variation. Acta Bot. Neerl. 39:129-144.

Karp, A. and W. J. Bright. 1985. On the causes and origins of somaclonal variation. Oxford Surveys of Plant Molecular & Cell Biology Vol. 2, p. 199-234.

Torres, K. C. 1989. Tissue culture techniques for horticultural crops. Chapman & Hall, New York.

Wagner, W. L., D. R. Herbst and S. H. Sohmer. 1990. Manual of the flowering plants of Hawai'i. University of Hawaii Press, Bishop Museum Press. p. 784.

Storing Seeds of Native Hawaiian Rainforest Plants

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Until now, there have been very few studies of seed longevity of native Hawaiian plants. Most rainforest plants world-wide have short-lived seeds (Vázquez-Yanes and Orozco-Segovia 1993) and there is no reason to expect Hawaiian rainforest plants to be exceptions. However, the only earlier studies of seed longevity of native Hawaiian plants have been of *Sophora chrysophylla* (mamane) (Akamine 1951) and *Vaccinium* spp. (ohelo) (Vander Kloet 1993). In 1995, we began a long-term study of native plant seed longevity. We will submit the full results elsewhere as a formal scientific paper in a professional journal. Here we wish to report results that are of practical interest to those propagating native plants.

We collected seeds from native plants growing on the rim of Mānoa Valley behind Honolulu. After collecting seeds, we cleaned them of pulp, air-dried them at room temperature, then stored them under four storage conditions:

1. Room temperature & humidity at the Lyon Arboretum: 13-29°C, 58-98% relative humidity. This simulates natural air conditions.

2. Room temperature, dry, in sealed containers with dessicated silica gel: 13-29°C, <10% relative humidity (treatments for *Clermontia kakeana*, *Cyanea angustifolia*, the *Peperomia* species were modified to 16-26°C, <10% relative humidity).

3. Refrigerated, ambient, in vented containers in a refrigerator: 4°C, 20-30% relative humidity.

4. Refrigerated, dry, in a refrigerator in sealed containers with dessicated silica gel: 4°C, <10% rel. hum.

For some species, we did not have enough seeds to test all of the storage conditions.

To assess fresh seed viability, we germinated samples shortly after collection. From time to time, we took samples from the stored seeds and attempted to germinate them to assess changes in their viability as they aged.

Results and Discussion

Table 1 summarizes our findings. After storage at room temperature and humidity, none of the species retained substantial viability after one year. However, some species continued to germinate well after one year or more of storage under reduced humidity or temperature regimes.

These findings have both practical and theoretical implications:

1) In general, seeds of most native Hawaiian rainforest plants are probably short-lived under natural conditions.

2) There is probably not a large soil seed bank of native rainforest plant seeds awaiting a favorable opportunity to germinate.

3) Those who grow native rainforest plants should germinate collected seeds shortly after collection instead of trying to store them, unless there are compelling reasons for storage. If it is necessary to store seeds, manipulating storage temperature and humidity can greatly extend the storage life of at least some species. See the tables for guidance.

Note that seed viability varies from plant to plant and from year to year. While the general

Table 1. Percent germination of freshly collected seeds and seeds after 1 year under different storage treatments. "n" indicate the number of seeds tested. Half-life is the estimated storage time after which germination rate is reduced to 50% of the rate for fresh seeds. Number in parenthesis is the length of time that seeds have been stored thus far. See text for details of treatment conditions.

		Storage Treatments			
Species	**Fresh**	**1**	**2**	**3**	**4**
Antidesma platyphyllum	85%	0%	—	—	0%
n =	100	100	—	—	100
half-life (1 yr.) =		<2 mo.	—	—	2 mo
Bidens sandvicensis	—	—	—	—	—
n =	—	—	—	—	—
half-life (6 mo.) =		3+ mo.	>6 mo.	>6 mo.	>6 mo.
Boehmeria grandis	44%	0%	36%	46%	45%
n =	200	200	200	200	200
half-life (2 yr.) =		4-6 mo.	>1 yr.	>2 yr.	>2 yr.
Clermontia kakeana	94%	0%	93%	—	99%
n =	300	200	200	—	200
half-life (2 yr.) =		6 mo.	>2 yr.	—	>2 yr.
Cyanea angustifolia	90%	0%	32%	—	24%
n =	50	200	200	—	200
half-life (1 yr.) =		1 mo.	10 mo.	—	8 mo.
Hedyotis terminalis	75%	1.5%	52%	73%	48%
n =	200	200	200	200	200
half-life (2 yr.) =		>6 mo.	>1 yr.	>2 yr.	>1 yr.
Labordia tinifolia	54%	0%	71%	65%	54%
n =	100	100	100	100	100
half-life (2 yr.) =		<2 mo.	>1 yr.	<2 yr.	>1 yr.
*Peperomia leptostachya**	80%	0%	—	—	0%
n =	50	25	—	—	25
half-life (3 mo.) =		<3 mo.	—	—	<3 mo.
Peperomia sandwicensis	53%	0%	0%	—	0%
n =	120	60	20	—	40
half-life (4 mo.) =		<2 mo.	<2 mo.	—	<2 mo.
Psychotria kaduana	90%	0%	—	—	—
n =	20	20	—	—	—
half-life (1 yr.) =		3 mo.	—	—	—
Psychotria mariniana	55%	0%	0%	0%	0%
n =	40	20	20	20	20
half-life (1 yr.) =		<2 mo.	<2 mo.	3 mo.	—
Psydrax odorata	50%	0%	—	—	26%
n =	50	50	—	—	50
half-life (1 yr.) =		3 mo.	—	—	1 yr.
Scaevola gaudichaudiana	60%	0%	—	—	—
n =	50	50	—	—	—
half-life (1 yr.) =		6 mo.	—	—	—

* Fresh seed figures are for seeds stored 1 month.

rank of the storage treatments effects is likely to stay constant, the percentages of germination and actual longevity for any given batch may vary considerably from our figures.

So far we have only tested seeds of rainforest plants. It is possible that plants from more seasonal environments may have seeds which have more effective mechanisms for surviving from one growing season to the next. Other storage conditions which we have not yet tested may be effective for those species whose storage lives we were unable to prolong; seeds of some rainforest plants from other areas are known to require moist storage, and can remain

viable for years if kept damp in the dark (King 1980, Vázquez-Yanes and Orozco-Segovia 1996). Much research remains to be done, and its results promise to have important implications for the conservation of Hawaiian plants.

Acknowldements

We would like to thank Dr. Michael Hadfieid of the University of Hawai'i Department of Zoology for providing access to climate-controlled greenhouse facilities, Dr. Guillermo Goldstein of the University of Hawai'i Department of Botany for his advice, and the staff of the Lyon Arboretum for supplies and support.

Literature Cited

Akamine, E. K. 1951. Viability of Hawaiian forest tree seeds in storage at various temperatures and relative humidities. Pac. Sci. 5: 36-46.

King, M. W. and E. H. Roberts. 1980. Maintenance of recalcitrant seeds in storage. In: Chin, H. F. and E. H. Roberts, ed. Recalcitrant crop seeds. Kuala Lumpur, Malaysia: Tropical Press, SDN. BHD. p. 53-89.

Vander Kloet, S. P. 1993. Biosystematic studies of *Vaccinium* section *Macropelma* (Ericaceae) in Hawaii. Pac. Sci. 47: 76-85.

Vázquez-Yanes, C. and A. Orozco-Segovia. 1993. Patterns of seed longevity and germination in the tropical rainforest. Ann. Rev. Ecol. Syst. 24: 69-87.

Vázquez-Yanes, C. and A. Orozco-Segovia. 1996. Comparative longevity of seeds of five tropical rainforest woody species stored under different moisture conditions. Can. J. Bot. 74: 1635-1639.

Appendix

Cross-Reference of Scientific and Common Plant Names

Antidesma platyphyllum	hame
Bidens sandvicensis	ko'oko'olau
Boehmeria srandis	akolea
Clermontia kakeana	oha wai
Cyanea angustifolia	haha
Hedyotis terminalis	manono
Labordia tinifolia	kamakahala
Peperomia leptostachya	ala'ala wai nui
Peperomia sandwicensis	ala'ala wai nui
Psychotria kaduana	kopiko kea
Psychotria mariniana	kopiko
*Psydrax odorata**	alahe'e
Scaevola gaudichaudiana	naupaka kuahiwi, mountain naupaka

* =*Canthium odoratum*

The Useful Plants of Coconut Island

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While awaiting an exciting ride on Hokule'a the afternoon of February 15, 1997, I photographed and collected some of the useful coastal plants on Coconut island, to be discussed with the Windward District school teachers during the sail. The sail started from Coconut island (Maku O Loe), ended in Hakipu'u-Kualoa on the Windward side of O'ahu. The event was part of the educational programs "Malama Hawai'i" (Caring of Hawai'i), conducted by the Polynesian Voyaging Society, Queen's Health System, Bishop Museum, and the Hawai'i Maritime Center.

Princess Bernice Pauahi Bishop planted coconut trees on the west side of Coconut island. It was reported that in 1890 the island was infested with Lantana weeds. Sheep were brought to the island in an attempt to clear the land (Devaney et al., 1976).

The island was purchased by E.W.Pauley in 1946. He donated several acres of the property along with a monetary gift to the University of Hawai'i in 1951. The University subsequently built the Marine Biological Laboratory, which later became the Hawai'i Institute of Marine Biology.

There are a number of edible, medicinal and other valuable coastal plants in the island. American mangrove, as shown in Figure 2 (*Rhizophora mangle*, Rhizophoraceae), is a tree, 10 feet high, having stilt roots. Leaves are glossy, leathery, sharp pointed, elliptical, 4 inches long by 2 inches wide and arranged in opposite pairs. The hard, persistent calyx has 4-lobes. Greenish-brown pendant fruit is produced (Wagner et al., 1990). The Asians and Pacific islanders used the trunk for construction and the branches for firewood.

• **Sea Grape** (*Coccoloba uvifera*, Polygonaceae), is 20 feet high. Leaves are glossy, thick, orbicular, 8 inches in diameter. Flowers are fragrant, arranged on 6 inch long spikes. Reddish fruits, hanging in clusters, look like grapes. Neal (1965) reported that the leaves were used for writing paper in Mexico. The trunk has been used in cabinet work and for fuel. The bark produces gum for tanning and for throat ailment. Jam, jelly, and an alcoholic drink is made from the fruit. The root is used for dysentery.

• **Milo** (*Thespesia populnea*, Malvaceae, Fig. 1), is a tree reaching 30 feet in height. Leaves are shiny, cordate (heart shape) with yellow flowers turning orange at dusk. The trunk is used to make bowls, and for cabinet work and flooring. The young leaves are eaten raw or cooked. Flower buds are edible (Singh and Arora, 1978).

• **Coconut** (Niu, *Cocos nucifera*, Arecaceae), reaches a height of 100 feet. Pinnately divided lobe. Monoecious, with male flowers are at the tip and female flowers are at the base of the inflorescence. Large one-seeded fruit is enclosed in a fibrous husk and hard shell. The trunk is used for sculpture and drums; the center portion at the base of the trunk contains edible starch. While leaves are for weaving baskets, floor mats, brooms, and thatching the house; the husk is for cordage and tooth brushes. The shell makes a handy eating utensil, and is burned into charcoal. The meat is eaten raw, grated and pressed for milk, oil and copra. Coconut water contains lots of calcium, phosphorus, some protein, fat, iron, and vitamins (thiamine, riboflavine, niacin, ascorbic acid). The globular, spongy embryo is also edible. Sap is collected by slicing the young inflorescence, and letting the liquid drip into a container. It can be drunk fresh,

fermented into palm wine, or boiled for syrup (Murai et al., 1958).

• **Tree Heliotrope** (*Tournefortia argentea*, Boraginaceae, Fig. 2), is 40 feet high. Silvery leaves are covered with pubescent hair, lanceolate and alternatingly arranged, while tiny white flowers abound in scorpioid cymes. Fruits are small, round and greenish-white when mature. The young leaves are edible (Whistler, 1980).

• **Iron Wood** (Paina, *Casuarina equisetifolia*, Casuarinaceae, Fig. 3), is a 50 foot tall tree with pendulant , slender , green branchlets. Scale-like leaves are in whorles of 6. Male flowers are at the tip of branchlets in spikes. Female flowers come from the leaf axil, forming a cone-like fruit. The trunk is used for house posts, canoe components, tools, and war clubs. Inner bark is scraped, mixed with water as an astringent, to combat chronic dysentery and diarrhea. It is also used to calm mentally disturbed or aggressive persons(Woodley, 1991).

• **Pickle-weed** (Akulikuli-kai, *Batis maritima*, Bataceae, Fig. 4), is a sprawling herb, 2-3 feet long with smooth, cylindrical, succulent leaves, an inch long, arranged in opposite pairs. Dioecious. Male flowers are at the tip of the plant. The female plant has oblong cylindrical spikes at leaf axil, half an inch long. The leaves are eaten raw (Neal, 1965).

• **Kalapini** (*Pluchea indica*, Asteraceae, Fig. 5), is a shrub, 5 feet tall. Ovate, serrated leaves are alternatingly arranged. Compound corymb inflorescence, light purple flowers turn off white when mature. The young leaves and flower buds are edible. They are also used for indigestion, as appetite enhancers, for fever, scabies, body odor, cervical tuberculous lymphadenitis, and rheumatism (Wijayakusuma et al., 1992).

• **Vervain** (*Stachytarpheta urticifolia*, Verbenaceae, Fig. 6), is a 3 foot tall shrub. The ovate, rough textured, serrated leaves are oppositely arranged. Blue flowers, sessile on a long erect spike. The leaves are used in tea for kidney infections, rheumatism, pharyngitis, irregular menstruation, and blood cleansing. The leaves are used topically for infected tissue. Flowers are for hepatitis A (Wijayakusuma, 1992).

• **Partridge Pea** (Lauki, *Chamaecrista nictitans*, Fabaceae, Fig. 7), is a small herb, 3 feet tall. Each pinnate leaf has 10-26 pairs of leaflets. Bright yellow single flowers emerge from the leaf axil. Fruit is a flattened pod, 1 1/2 inches long, containing 12 seeds. The leaves cure malaria and eczema. The root relieves stomach trouble (Lubis, 1983).

• **Ivy Gourd** (*Coccinia grandis*, Cucurbitaceae), is a climbing plant with incised lobes , and broad, tender, glabrous leaves. A large, white, bell-shaped flower comes from the leaf axil. A small cucumber-like fruit turns bright red when mature. All parts of the plant are edible, and also used for fever and lowering blood pressure (Lubis,1983).

• **Popolo** (*Solanum americanum*, Solanaceae, Fig. 8), is a 3 foot high bush with incised lobe and oval leaves, 1-2 inches long. Three to four tiny white flowers exist in a cluster of umbel. Black berries, one-fourth inch in diameter are produced. Prepared in tea for coughing, sore throat, and as a tonic and laxative. The leaves are pounded with salt to heal wounds (Merril, 1943).

• **Plantain** (Laukahi, *Plantago major*, Plantaginaceae, Fig. 9), is a rosette, perennial herb with broadly oval leaves, 2-5 inches long. Tiny greyish flowers are arranged on 4-6 inch erect spikes. The leaves are edible, containing sugar, citric and oxalic acids, emulsin, invertin, and aucubin. They are used as poultice for sores, boils, and to stop bleeding. The seeds act as a diuretic (Keys, 1976).

Literature Cited

Devaney, D. M., et al. 1976. Kaneohe: a History of Change (1778-1950). Bishop Museum Press, Honolulu.

Keys, J.D. 1976. Chinese Herbs - Their Botany, Chemistry, and Pharmacodynamics. Charles E. Tuttle Co. Rutland, Vermont.

Lubis, S. 1983. Mengenal Apotik Hidup (Obat Asli Indonesia). C. V. Bahagia, Pekalongan.

Merrill, E.D. 1943. Emergency Food Plants and Poisonous Plants of the Islands of the Pacific. Technical Manual 10 - 420. U.S. Government Printing Office, Washington.

Murai, M., F. Pen, and C. D. Miller. 1958. Some Tropical South Pacific Island Foods. University of Hawai'i Press, Honolulu.
Neal, M. C. 1965. In Gardens of Hawai'i. Bishop Museum Press, Honolulu.
Singh, H. B. and R. K. Arora. 1978. Wild Edible Plants of India. Indian Council of Agricultural Research, New Delhi.
Wagner, W. L., D. R. Herbst, and S. H. Sohmer. 1990. Manual of the Flowering Plants of Hawai'i. Volume 1 and 2 . Bishop Museum Press and University of Hawai'i Press, Honolulu.
Whistler, W. A. 1980. Coastal Flowers of the Tropical Pacific. The Oriental Publishing Company, Honolulu.
Wijayakusuma,H. M. H. et al. 1992. Tanaman Berkhasiat Obat Indonesia. Volume 1. Pustaka Kartini, Jakarta.
Woodley, E. 1991. Medicinal Plants of Papua New Guinea. Part 1: Morobe Province. Verlag Josef Margraf, Weikersheim.

Fig. 1. Milo, *Thespesia populnea.*

Fig. 2. Tree Heliotrope, *Tournefortia argentea.*

Fig. 3. Ironwood, *Casaurina equisitifolia.*

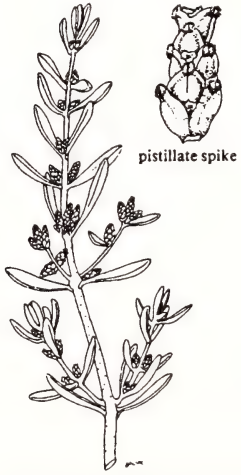

Fig. 4. Pickle-weed, *Batis maritima.*

(All line drawings from Wagner et al., 1990, *Manual of the Flowering Plants of Hawai'i.*)

Fig. 5. Kalapini, *Pluchea indica.*

Fig. 6. Vervain, *Stachytarpheta urticifolia.*

Fig. 7. Partridge Pea, *Chamaecrista nictitans.*

Fig. 8. Popolo, *Solanum americanum.*

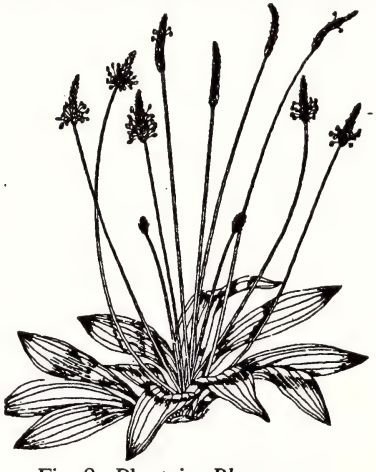

Fig. 9. Plantain, *Plantago* sp.

Income Tax Consequences of Botanical Society Membership

Alvin Y. Yoshinaga
Membership Chairman

(Editor's note: As the first of the year rolls around, it is time to start thinking of making our annual contribution to Uncle Sam. This timely reminder from the society has been prepared to help with any questions you may have. *CWM)*

Questions sometimes arise about whether members can deduct dues and donations to the Botanical Society from their income tax returns. Briefly, the answer is yes for both:

The Botanical Society is recognized as a tax-exempt organization under Section 501(c)(3) of the Internal Revenue Service Code. See Newletter of the Hawaiian Botanical Society 36(1): 29 (March 1997) for details. The tax code permits members to deduct dues from their tax returns, minus the fair market value of any goods or services to which membership entitles them. (Members' newsletters, meeting notices, and other similar items of small value need not be considered.) The Society provides no goods or services not equally available to non-members, so the full value of your dues is deductable.

Similar considerations apply to donations. If you want to deduct a donation of $250 or larger, the IRS requires a letter specifying the exact amount and date of the donation and reporting the fair market value of any goods or services received. If you wish to have a letter for a smaller donation, the membership chairman or treasurer will gladly write one for you .

For gift memberships, the tax deduction belongs to the giver, not the recipient. Lifetime memberships are deductable at one time during the year in which the dues were paid.

Common Native Hawaiian Plants Worthy of Cultivation

John K. Obata

The most pressing question is what species can I grow. There are a few time tested species that will grow under most urban, Honolulu conditions. Generally, most of the natives under cultivation prefer a well drained, drier habitat. Those living in drier areas should be more successful from those living in wetter, upland areas.

Two species are easily cultivated under most conditions although they naturally grow in a higher, drier habitat. They are ʻaʻaliʻi (*Dodonaea viscosa*) and naio (*Myoporum sandwisence*). ʻAʻaliʻi poses a unique problem. Its plants are unisexual, one plant pistillate and another staminate. In order for lei makers to have the many fruited capsules, a male and a female plant must be planted. Otherwise fertilization will not occur. At times a pistillate plant will form a few staminate flowers to accomodate some pollination. This species requires an excessive amount of sunshine to be productive. It can reach maturity in about a year when cultivated.

Naio grows rapidly and blooms within a year after germination. When matured it is constantly in bloom. It has an undesirable habit of throwing lateral roots above ground when matured. The lowland, coastal forms become bushy. The upland types tend to be more arborescent, but tends to be bushy under lowland cultivation. Both naio and 'a'ali'i are quite free of insect pests and require hardly any care once they establish themselves.

Another worthy by the ease of cultivation is ala'he'e (*Canthium odoratum*). It becomes a small tree and resembles the mock orange bush. It blooms several times a year with a cluster of small, fragrant white flowers.

Seemingly most species of Hoawa (*Pittosporum* sp.) can be cultivated with ease. Some species make elegant landscape plants. Unfortunately seeds are few even in nature. Many seeds lack embryos suggesting perhaps the lack of a pollinator. Artificial pollination also yielded very few seeds in one species.

For a bushy plant with semi-silvery leaves when exposed to excessive sunlight is kului (*Nototrichium sandwicense*). It seems to grow under most conditions, but prefer a rather dry, very sunlit area. Then the leaves give a silvery sheen.

Uʻulei (*Osteomeles anthyllidifolia*) makes an excellent hedge or ground cover. It has dark green, pinnately compound leaves with a single petaled, white rose flower. It is adapted to both wet or dry conditions. Does equally well in shade as well as in full sunlight, but prefers the latter. This species literally grow with neglect.

Pohinahina (*Vitex ovata*) also can be a good ground cover in dry, lowland lanscapes. Its prostrate growth habit with its purplish flowers make them rather attractive. It is used frequently in haku leis.

For palms, the native loulu (*Pritchardia*) adapts from sea level to about 1200 m (4000 ft). They do not seem to have any major preditors. All the natives species adapt well to lowland cultivation.

For the tea drinkers, Koko'olau (*Bidens*) is cultivated. most species seem to be perenials. Few alien insect make frequent attack on them. The other commonly grown plant is ilima (*Sida fallax*) for lei making. It lives over three years, but if the ground with infested with nematodes, its life span is about one year.

This is a general assessment of the commonly grown plants.

Growing Native Hawaiian Plants

John K. Obata

During the last ten years, interest in growing our native Hawaiian plants accelerated beyond that of the previous thirty-five years. Before the 1960's attempts were few and results quite feeble. Often the success rates were quite negligible. Many during those years felt that it was quite impossible to artificially cultivate our native flora. But today interests have accelerated and even non-botanically oriented individuals have joined the researchers and the commercially oriented ones and the growing success rates have drastically improved.

Perhaps now is the time to assess some of the pitfalls that an enthusiastic neophyte might encounter. They were the backbone of introducing new cultural techniques. Many of the break-throughs in growing our native flora resulted from their work and from neither the academics or nursery industry.

Cultivating native Hawaiian plants poses a few peculiar problems. Generally most of them are not easily cultivated in urban, lowland areas. Some problems easily can be resolved while others require patience, skill and ingenuity. Generally pot culture is not difficult in a commercial potting mix if reinforced with a coarse material to facilitate better drainage. For young plants, a covered stand and media with good drainage is imperative. Watering and fungicides must be carefully monitored. Root-bound plants in pots must be watered daily or their demise will be very predictable.

Most of our native plants are very prone to fungal, bacterial, mite, and insect attacks. One tries to avoid the use of chemical sprays as many of the organic liquid base types have a solvent as benzene or xylol which have a tendency to "burn" tender leaves. Quite often spraying could be lethal. If it becomes necessary to spray, a powdered form is suggested. They are not as toxic as the liquid types, but spray should be judiciously used.

Mites are a major problem to native plants. However, many miticides are tolerated by the natives. But the best rule of thumb with the natives is to try to avoid use of any sprays.

Let us evaluate the pitfalls involving seed collecting, germination, and growing. Many problems, at times, may be peculiar to a single species or even a single clone whether it be a plantlet or even a seed. So recommendations are basically generalities for growing the Hawaiian flora.

Most of our native flora lack the "ease of growing characteristics" that garden variety seeds sold in garden shops have. One must remember our garden varieties have been bred and improved by a selective breeding program for many generations. Some varieties took many decades to develop. Their seeds, if fresh, usually should be very viable. In contrast our native flora, when field collected, provides us with seeds that are not selected and often display many negative attributes. Many have poor germination rates. Some species, such as hoawa (*Pittosporum sp.*) have very few viable embryos in their seeds. Perhaps they lack a good pollinator in the wild.

Often germinated seedlings lack vigor and easily fall victim to a myriad of fungal and bacterial diseases, all of them alien. They also fall prey to many alien chewing insects in our yards. The most noxious of them is the Chinese rose beetle which may even defoliate young tender leaves. Ha'a or hame (*Antidesma pulvinatum*) grows very vigorously in drier areas. However, its soft, shiny leaves are predated on by the Chinese rose beetle. It can easily defoliate a plant. And a garden slug can annihilate a young seedling or a community pot overnight. The negatives about growing natives are legion. But by just adhering to simple horticultural practices, one should be able to grow the natives. For instance many have difficulty growing the common tree ferns (*Cibotium* sp.). It is not difficult to grow an adult plant in full sunlight, if one only remembers to keep the crown of the plants constantly wet.

For the angiosperms, it is best to grow plants that come from a drier habitat in nature. It is quite difficult for those coming from wetter habitats. The science of plants growing in wet areas are not fully understood and its growing habits are not fully understood. Although dry land plants are better adapted to grow in low, urban habitats, this does not qualify them for cultivation in an urban landscape. Even an easy growing species may have many weak siblings. A horticulturally selective process must be instituted. Quite often the selection process is a clonal one. In the selective process, many are inclined to select easy and fast growing forms. Sometimes we forget longevity and plant size. In the infancy of this type of selective process, a lot depends on intuition at this stage.

In the past we focused on one desirable trait and forgot the total plant. One who breeds or grows must look at the total picture. Quite often it is not an easy goal to attain. A classical example is our state flower (*Hibiscus brackenridgei*), Against the recommendations of many of the field botanists, this plant was selected. The brilliant yellow flower was beautiful. Many of the other traits were overlooked. This plant is short lived in cultivation, often living less than two years. Its leaves are constantly eaten by the Chinese rose beetles and the ugliness is quite obvious. It starts to open late in afternoon and by mid-morning the blossoms begin to close. Its sepals and bracts are slightly "thorny."

Hopefully, one day each of our yards will be adorned with at least one native Hawaiian plant. It would be an enlightening sight to see our city and state buildings landscaped with various native Hawaiian plants other than beach naupaka (*Scaevola sericea*). Perhaps we can start with our schools so that the next generation will know and have an appreciation of what is Hawaiian. Hopefully it is not too late for the present generation and to those leaders entrusted with the saving of our native biota.

Minutes of the Hawaiian Botanical Society

May Meeting

• The May 5, 1997 meeting of the Hawaiian Botanical Society was called to order by Wisteria Loeffler, President.

• The minutes were approved as read.

• **Treasurer's Report.** There was no Treasurer's Report as the Treasurer was ill.

• **Membership Report.** Alvin Yoshinaga, Membership Chair, announced a total membership of 144 with 2 new memberships.

• **Old Business**
  • Reports were given on the Society's booth at Earth Day, the Manoa Cliff hike, fencing of protions of the Pohakuloa Training Area on the Big Island, and support of the Society for Senate Bill 175.

• **New Business**
  • Fund-raising suggestion of selling calendars made of pictures taken by members.

  • It was announced that member Izzie Abbott received the Gilber Morgan Smith Award and the *Miconia* eradication hike in Kalihi.

• **The Plant of the Month,** an update on biological control of kahili ginger, Hedychium gardnerianum, was given by Rob Anderson of University of Hawaii Department of Botany.

• **Guest Speaker.** The speaker for May was David Hopper of the U.S. Fish and Wildlife Service, speaking on "Pollination of Hawaiian Plants by Hawaiian Bees."

September Meeting

• The September 8, 1997 meeting of the Hawaiian Botanical Society was called to order by Curt Daehler, Vice-President.

• The minutes were approved as read.

• **Treasurer's Report.** Treasurer's Report was given by Ron Fenstemacher.

• **Membership Report.** Alvin Yoshinaga, Membership Chair, proposed one new member.

• **Old Business**
  • There was a discussion of selling calendars with pictures furnished by the membership.

• **New Business**
  • The passing of Dr. William Stewart, the founding director of National Tropical Botanical Garden, was announced.

  • Arron Lowe resigned as field trip coordinator and the need of a volunteer for a replacement.

  • An update on the critical habitat lawsuit included the possibility of a settlement with Fish and Wildlife.

• **The Plant of the Month,** was given by Katia Silvera on native orchids of Panama.

• **Guest Speaker.** The speaker for September was Louis Santiago of University of Hawaii Botany Department on "Neotropical Analogs to the Hawaiian Flora."

October Meeting

• The October 6, 1997 meeting of the Hawaiian Botanical Society was called to order by Curt Daehler, Vice-President.

• The minutes were approved as read.

• **Treasurer's Report.** No Treasurer's Report was given due to the Treasurer's absence.

• **Membership Report.** Alvin Yoshinaga, Membership Chair, had no new members to report to the society.

• **Old Business**
  • Discussion of selling calendars with pictures furnished by the membership continued. A suggestion of delaying the calendar until 1998 was made. Rick Palmer was suggested as a possible committee member.

• **New Business**
  • October 25th clean-up of Kaena Point.

  • Need for volunteers to survey Hawaiian videos with Randy Kennedy as the contact person.

  • The Waahila Ridge hike and the Oahu *Miconia* search were also announced.

• **The Plant of the Month,** was given by Linda Lenz, University of Hawaii Botany Department on Hawaii Volcanoes National Park Rare Plant and Invertebrate Inventory.

• **Guest Speaker.** The speaker for October was Susan Mooberry on the "Discovery of New Cytotoxic Agents from Pacific Higher Plants."

• **New Business**
  • Appointment of a nominating committee for Botanical Society officers and board members for the 1998 year. Orlo Steele, Mindy Wilkinson and Leilani Durand volunteered to serve on this committee.

  • Orlo Steele announced the restoration of native plantings on the rocky hill behind Punahou School and asked for volunteers to assist in the plantings.

  • A Nov. 15th clean-up of Kaena Point was announced.

  • Talks to be given by Jack Jeffery and Betsy Gayne on Nov. 13 and 19 sponsored by the Department of Land and Natural Resources was announced. Betsy also announced the availability of this downtown location for future seminars and discussions.

• **The Plant of the Month,** was given by C. Barton Potter, of the C. Barton Potter Co., on the *Acacia koa* stewardship on Maui and Oahu.

• **Guest Speaker.** The speaker for November was Daniel Harder of the Center for Plant Conservation. His topic was "The winged bean and the genus *Psophocarpus*."

November Meeting

• The November 3, 1997 meeting of the Hawaiian Botanical Society was called to order by Ron Fenstamacher, Treasurer. Three guests were introduced.

• The minutes were approved as read.

• **Treasurer's Report.** The Treasurer's Report was postponed until the December meeting.

• **Membership Report.** Alvin Yoshinaga, Membership Chair, proposed eight new members and were approved for a total of 191 members.

• **Old Business**
  • There was no old business to discuss.

December Meeting

• The December 1, 1997 meeting of the Hawaiian Botanical Society was called to order by Curt Daehler, Vice-President. Two guests were introduced.

• The minutes were approved as read.

• **Treasurer's Report.** Ron Fenstemacher, Treasurer, reported $3247 in the society's account at the end of 1997.

• **Membership Report.** Alvin Yoshinaga, Membership Chair, proposed two new members to the society, and 1 life membership was added.

• **Old Business**
  • There was no old business to discuss.

- **New Business**
  - Election of officers for the 1998 year took place. The nominating committee proposed the following candidates:

President:	Mindy Wilkinson
Vice-President:	Alvin Yoshinaga
Secretary:	Leilani Durand
Treasurer:	Ron Fenstemacher
Board of Directors:	Curt Daehler
	Gerald Toyomura

The nominations were closed and the proposed candidates were approved unanimously.

- The formation of a new botanical garden called "Pua Mau" on the Kona side of the Big Island was announced.

- The December hike to Mount Ka'ala was announced.

- A garage sale fund-raiser was tentatively scheduled for February.

- Rick Palmer asked the membership for images for a 1999 Botanical Society calendar.

- **The Plant of the Month,** was given by Ron Kodoma of the Honolulu Zoo on the Spineless Peach Palm (*Bactris gasipaes*).

- **Guest Speaker.** The scheduled main speaker was unable to attend, but Will McClatchy from UH Botany Department kindly volunteered to speak on "Useful Palms of Fiji."

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Do you have something you would like to contribute to the *Newsletter*? All contributions are welcome. They may be technical articles related to on-going research, comments about current events, or field observations you may have made from a recent expedition. Contributions may be sent to the *Newsletter* Editor via manuscript, disc (please provide hard-copy also), or E-mail at:

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